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MINISTRY OF
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Project Report

on

Drone: A New Age Policing Tool

(Project No.13/MM:03)

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ABSTRACT

Drones are popular not only as recreation for enthusiasts but also as a tool with huge potential to achieve a superior, efficient and accurate method of surveillance, sought after by different security agencies. Commonly, the word “Drone”, in its most basic technical sense, means an unmanned aircraft i.e., a flying robot with a remote controller. They can be further augmented with GPS, cameras, various sensors, and specialized programs such as autopilot, etc. for increasing their usefulness in data collection and aerial monitoring.

Drones have a vital role in our future society as they can be employed for various uses apart from surveillance and VIP security such as monitoring climate change, carrying out search operations in natural disasters, delivering goods, photography, filming, geographic mapping, traffic management, bomb detection (digital smelling technology), bomb disposal, law and order, crowd monitoring, etc.

As of today, Drones remain under-exploited in these various fields and are mostly in their infancy stage in terms of technology. However, this barrier will soon be broken as a result of rapid advancement in technology as well as increasing accessibility to electronic components. Moreover, Drone technology has caused a shift in the task execution process from the traditional way of management to a more efficient, effective, and futuristic way of management. Over the past few years, various private agencies, as well as governmental organizations, have managed to use Drones for activities ranging from not only easy tasks such as quick deliveries during an emergency, but also difficult operations like scanning unreachable military bases. Drones are extremely useful in places which are either inaccessible due to local circumstances or when it is difficult to perform a task in a timely and efficient manner.

The decade of 1990s introduced the 1st generation Drones. The technology has become more refined in the recent past.

Drones are being widely used throughout the world. As technology advances, we will witness 7th generation Drones which will be intelligent smart Drones based on Artificial Intelligence.

Drones are getting more attention mainly in four sectors: Military, Commercial, Personal, and Future Technology. However, this also raises safety concerns in misuse of this high potential technology.

In this paper, various scenarios are also discussed which provide a broad insight as to how the police department can tackle the difficulties which arise from the usage of Drones by other parties. In light of the Drone Rules 2021, it is expedient to create a special security agency to perform quick response in case of both Drone and Counter-Drone related activities. In this regard, Telangana State Police Department is one of the first in the country to propose a full-pronged, multi-departmental agency called Hi- DRA to ensure highly coordinated, smooth, and safe Drone operations. At the same time, there is a need to increase public awareness about Drone Technology to achieve peaceful use of Drones in the coming decades.

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CHAPTER 1
INTRODUCTION AND BACKGROUND

1. Introduction

A drone, in technical terms, is an unmanned aircraft. It is robotic device which can fly over a desired area and be remotely controlled through software-controlled flight plans working in conjunction with sensors and GPS.

Drones have a wide range of application in various sectors viz. search and rescue operations during/after disasters, photography, movie shooting, monitoring climate change, delivering goods, etc. Drone are called by different names viz. Unmanned Aerial Vehicles (UAVs), Miniature Pilotless Aircraft, or Flying Mini Robots, and they are rapidly growing in popularity. Drones are still in the nascent stage in terms of mass adoption and usage.

Over the past few years, drones have become a crucial resource for various businesses (Large/Medium and even Micro enterprises) and Government organizations and have managed to penetrate areas where certain industries were either stagnant or lagging. Drones are proving to be extremely useful in places where a human being cannot reach or is unable to perform a desired task in a timely and efficient manner. A few of the top benefits that drones offer to the industries globally are increasing work efficiency and productivity, decreasing work load and production costs, improving accuracy, resolving security Issues, etc.

Whether drones are controlled by a remote or accessed via a smartphone app, they possess the capability of reaching the most remote areas with little to no manpower needed and require the least amount of effort, time, and energy. This is one of the major reasons why drones are being adopted globally, especially in four sectors viz. Defence, Commercial/Business operations, Personal, and Future Technology.

1.1 History of drone technology and its use in today's world:

Drones have been in use for more than two decades. The idea of automatic unmanned airplanes was first thought of by USA& France during World War I. Those ideas and attempts laid the foundation for drone technology. During the 21st century and especially since the last few years, there have been significant developments in drone adoption, usage expansion across industries, and world wide awareness.

1.2 Evolution of Drone Technology:

Drone technology has seven potential generations, and the majority of current technology sits in the fifth and sixth generations.

Here is the breakdown of the technology generations:

1. Generation 1: Basic remote control aircraft of all forms
2. Generation 2: Static design, fixed camera mount, video recording and still photos, manual piloting control
3. Generation 3: Static design, two-axis gimbals, HD video, basic safety models, assisted piloting
4. Generation 4: Transformative designs, Three-axis gimbals, 1080P HD video or higher-value instrumentation, improved safety modes, autopilot modes.
5. Generation 5: Transformative designs, 360° gimbals, 4K video or higher-value instrumentation, intelligent piloting modes.
6. Generation 6: Commercial suitability, safety and regulatory standards based design, platform and payload adaptability, automated safety modes, intelligent piloting models and full autonomy, airspace awareness
7. Generation 7: Complete commercial suitability, fully compliant safety and regulatory standards-based design, platform and payload interchangeability, automated safety modes, enhanced intelligent piloting models and full autonomy, full airspace awareness, auto action (takeoff, land, and mission execution).

From technically manning sensitive defence areas to luring hobbyists throughout the world, drone technology has developed and prospered in the last few years. Individuals, commercial entities and governments use drones for multiple ends, including:

- Aerial photo/videography for movies, events & journalism
- Unmanned Cargo delivery and shipping
- Supplying essentials for Medical health & disaster management
- Building safety inspections
- Precision crop monitoring
- GIS mapping of inaccessible locations topographical terrains
- search and rescue operations using Ultrasonic/thermal sensor drones
- Law enforcement and border control surveillance

In India, there are six segments across which drone-based solutions are being explored. These are given below.

Agriculture
• Compilation of plant count
• Calculation of fair crop loss percentage
• Crop supervision
• Crop maintenance
Insurance
• Collect crop yield data and assess damage for insurance purposes
• Catch discrepancies and fraudulent claims
• Risk-adjusted product pricing
Energy and utilities
• Remediation and site monitoring.
• Inspection of underwater intake pipe
• Survey grades map for siting transmission lines
Drone-based applications being explored in India
Media and entertainment
• Aerial documentary
• Aerial photography
• Cinematography
Infrastructure
• Industrial inspections
• 3D video mapping
• Land audit
• Town planning
• Site management via capturing, viewing and analysing aerial imagery and survey data
Mining
• Thermal imaging
• Terrain mapping and change detection
• Infrastructure and equipment inspection

Figure 2: Drone Usage in India
(Source: Policy Framework for Use of Drone in India Research Paper by Gatkal Narayan)

1.3 OVERVIEW

1.3.1 Project Title: Drone - A New Age Policing Tool

The Project focuses on the utilization of drones in day- to-day policing.

1.3.2 Vision

The vision of the Project is to offer a template of use cases wherein drones can be conveniently and successfully pressed into service to empower and support police forces across states/UTs, including by proposing a structural mechanism for this purpose.

1.3.3 Project Objective

The objective of this Project is to showcase how drones can be used as a force multiplier for improving the efficacy and effectiveness of police in day- to-day policing. For this purpose, three broad themes have been identified:
Traffic Management in States/UTs.

i. Traffic Management in States/UTs.

ii. Bomb Detection and Disposal.

iii. Law & Order including during Elections with an emphasis on far-flung areas.

CHAPTER 2
TRAFFIC MANAGEMENT IN STATES/ UTs

Drones are increasingly used in traffic management in India. Indian cities face the problem of ever-increasing vehicular traffic. Traffic monitoring with fixed cameras is getting increasingly inefficient as they cannot identify issues beyond their immediate location. Traffic police and urban transportation planners need to analyze traffic density, road capacity, and traffic flow in order to draw strategies to reduce urban congestion improve traffic times and reduce fuel consumption.

Traffic monitoring via drones can overcome the limitations of traditional methods of monitoring due to its simplicity, mobility, and ability to cover large areas. High resolution real-time videos from drones can be relayed to the command-and-control center to assist on-ground personnel in road monitoring, traffic guidance, traffic activity analysis, tracking vehicles, reading number plates, etc. For continuous (day & night) surveillance, Drones can have attachments like HD cameras, thermal imaging cameras and any other task specific instruments. They can provide on-ground situation awareness in case of emergencies viz. oil leaks, vehicle breakdowns, accidents, etc. and evidence in accidents can be collected for the same. The data collected by drones can be analysed to enable authorities to improve traffic flow and safety of road users.

2.1 Scenarios

Drones can be used in three broad ways for traffic management:

1. Road Safety – Collecting traffic and driving behaviour data, accident hotspot analysis, near miss accidents surrogate safety risk assessment, etc.

2. Traffic Congestion Monitoring – Traffic life flow analysis like speed, public announcements, crowd surveillance, parking occupancy, signal optimization, lane discipline, vehicle chase, recognizing traffic violations, and traffic queue length. For example:

- Ambulance and fire engine can be seen at a distance & cleared.
- Vehicle breakdown can be seen and mobile parties dispatched.
- Swarm of drones across, say 10 junctions, can be used to monitor traffic congestion propagation across junctions and can analyze the impact of stop-and-go vehicles like taxis, buses and delivery vehicles in causing local disturbances in traffic flow.

3. Road Infrastructure Management — Bridge inspection, road inspection - detect road damages, potholes, damage to pedestrian pavements, and footpath encroachment. The traffic police can further use the drone for surveillance over festivals, political agitations, Emergency call Dial 100 can be developed to instantly dispatch a drone to collect video evidence, give warning flashlight or PA system announcement, etc.
4. Artificial Intelligence (AI) & Machine Learning (ML) and Drones: Integrating drones with AI and ML technology, along with tools like Google Maps & bandobast arrangement can significantly enhance traffic management and VIP security arrangements. Drones can relay real-time information to a command and control center, where AI and ML algorithms analyze the data to organize and optimize deployment strategies for security and traffic control effectively.

2.2 Procurement strategy

The main points to be looked at while purchasing drones for traffic purposes are :

1. Obtaining “Make in India” drones as foreign-made drones are banned for importing. The drone to be used by police must be registered on the “Digital Sky” website of the Directorate General of Civil Aviation (DGCA). The main consideration to choose from can be ease of use, payload, quality of images, weight, time/distance of the flight, battery life, etc.

2. Training and license: Police personnel can be trained at DGCA approved training institutes across the various States of India. Apart from flying, training is also imparted in the assembly, repair, and maintenance of drones.
3. Command-and-Control Centre: At each Police Headquarters, all police drones, apart from being able to be operated and viewed from a central drone console, should also be able to be viewed live and maneuvered live from the command-and-control center.
4. Video Analytics: “Data From Sky” kind of software, (It is a professional desktop application for advanced traffic surveys and traffic analysis using AI and machine learning methods) can be used to analyze vehicle types, vehicle speeds, etc., in the control room to arrive at conclusive decisions about signal timing, congestion, etc.

Specifications	**Mandatory Requirements**
Type of Drone	Multirotor
Drones Approved by DGCA/Digital sky platform	Yes
Able to fly in Red Zone	Yes
Flying/endurance Time	Minimum 35 mins
Camera	Minimum 20 X optical zoom
Live video transmission rate	Minimum 1080 P
Live photo Capture	Minimum 1080 P
Recorded Video	Minimum 1080 P
Flying range	Minimum 4 Kms
HDMI Out Port	GCS should have HDMI Out port for transmitting the live footage to
Drone live video streaming to Command Centre	Relaying live footage to Command Centre through Ground Control Stations using either LAN/Wi-Fi
Megaphone with man-pack	Should be audible to minimum of 100meters altitude

Overall drone communication & live video	Minimum of 4 Km
Night vision	Yes
AMC	One-year warranty for all spare parts
Drone Crash& System Failure which may occur due to technical issues in the instrument	100 % responsibility of the vendor
Training &Certification of DGCA	2 Teams (Each team with 2 pilots), should be provided at each district level to start with
Pilot Training	A technician from the concerned company should assist the department for 3 months for on the spot training.

2.3. Use case scenarios:

Case 1: Daily use by traffic constable at junctions

At peak traffic times, the constable in field junction has to make split- second decisions like how much time to allocate for each side in a 4-way junction. One of the main criteria he/she uses is traffic queue length, which indicates for how much distance on that side of the road there are vehicles. If all 4 sides of the 4-way junction are in a visual line-of-sight, then he can see and determine but when they are not in a visual line-of-sight, then another constable is required to be posted just to tell over VHF set whether a traffic jam has reached a specific landmark or whether not to let that signal turn green. In this scenario, the drone can be flown and hovered to see what the traffic queue length is where by the manpower requirement is reduced. Also, the traffic constable has to give clearance for emergency vehicles like ambulances and fire engines on priority. When traffic congestion is long, emergency vehicle sirens may not be heard, but if a drone is flown then such vehicles can be given spotted green light clearance.

Similarly, say there is a vehicle break down on a flyover. It is impossible to realize why there is a traffic jam until one reaches the spot, but if a drone is flown, the breakdown can be spotted and details sent to the control room like the location of the

vehicle breakdown, type of vehicle and extent of traffic jam and alternative route for police crane to reach the spot to tow away the vehicle. Also, for VIP vehicles traffic clearance can be given at an appropriate time as they reach the junction. Thereby, traffic signal optimization and optimum usage of roads is achieved.

Case 2: Traffic management during political or religious rallies

All through the year, large rallies on foot or vehicles occur in many parts of the country. They need to be observed in order to regulate the rest of the city traffic for the general public. Many times, Police try to keep the entire rally intact and try not to let it enter side lanes or unintended areas which may cause communal tensions or unplanned traffic jams. Further, when a rally moves the upcoming next junctions divert traffic to other junctions. Once the rally has passed, the traffic has to be restored in the junctions to which traffic had been diverted, too. For the above purposes, the drone can be flown to see if the rally is intact or not and traffic diversions can be planned in real-time based on the drone footage.

Case 3: Accident Hotspot/Road Analysis

At accident hotspots, drones can be flown to see if there are any geometric corrections to be made to the road or road intersections. Coupled with LIDAR (Light Detection and Ranging – The system uses pulsed lasers to map a three-dimensional model of an environment) jeeps they can also do 3D mapping and give a virtual placement (A digital prototype of a layout can be created prior to implementation on real ground. This allows administration to visualize the plan & make necessary changes if required) of lighting in nights, junction poles, barricades, speed breakers, signages, radium markings, road markings, etc. which can be used by engineering departments to design changes at accident hotspots to reduce fatalities. Drones can also detect potholes, pavement encroachments, and waterlogging prone areas in monsoons which can cause traffic jams.

Accident scene documentation requires a highly trained crew of forensic experts, including crime scene photographers, who meticulously capture detailed evidence from specific angles under precise conditions. The exact scene must be documented for further investigation, even after the scene is cleaned up. It can take a long time for

a photographer to fully document a scene with proper measurement references. In the case of a traffic accident, this requires the roads to be closed while the work takes place for measuring skid marks, the position of vehicles, and other details all while holding up traffic. Drones can reduce photography time to well under an hour. Using a few simple ground measurements as reference points, drones can be used to fly over the incident site to capture. Photographs/videos and the same data can be used to analyse and conduct most of the accident investigation from a computer system rather than physically visiting the site.

Case 4: Incident Response payloads

Drones can be dispatched instantly in an emergency, say based on a Dial 100 accident call. Apart from the camera, the drone can carry different payloads as necessary, like extra lighting, a public address system, a first aid kit if there are injuries, or fuel if the vehicle needs fuel, etc.

Case 5: Traffic Intervention Impact study/Traffic volume study

Many times, at various junctions, police officers make interventions like opening or closing a U-turn or closing a route, etc. but their impact on the efficacy of that decision is not documented except for public or media feedback, which is subjective. Drones can be used to study the volume of traffic flow, and traffic density before and after the intervention. For this study scope must be defined, flight path determined, flight path recorded and then data interpreted with deep learning video analytics and AI- based software like Wintics/Data From Sky and analyzed to arrive at conclusions.

Case 6: Traffic enforcement by generating challans

Drones can capture speeding vehicles and parked vehicles in no parking areas, violations of traffic rules, etc., and generate challans accordingly.

CHAPTER 3
DRONES FOR BOMB DETECTION AND DISPOSAL

3.1 Existing Scenario

Today, bomb disposal enforcement units use ground-based robots to investigate suspicious packages. Aerial drones can be very useful in providing a primary assessment of the situation, based on which, an appropriate decision can be taken by bomb disposal units. It may not be feasible to use drones to touch & dispose of bombs, but information provided by drones would avoid wastage of resources and also enable quick action to save lives. In any bomb rescue operation, the time factor plays a vital role. As a bomb can explode at any moment, the primary task is to detect the bomb in fastest possible time by getting data to decision- makers who can monitor the situation. Drones can help in leveraging technology and reducing time delays that occur due to manual detection. Manual detection of bombs also involves high physical risk and takes longer time.

At present, at the National Level, bomb detection and disposal is done by :

- National Security Guard's Bomb Squad- there are five NSG hubs in the country.
- Army's Bomb Squad – they do BD work in their respective area of jurisdiction.

At the State Level, Bomb Detection and Disposal Squads (BDDS) are working in most of the States and UTs.

3.2. Role of Drone in Anti-Sabotage Check

3.2.1. Road Opening Party (ROP)

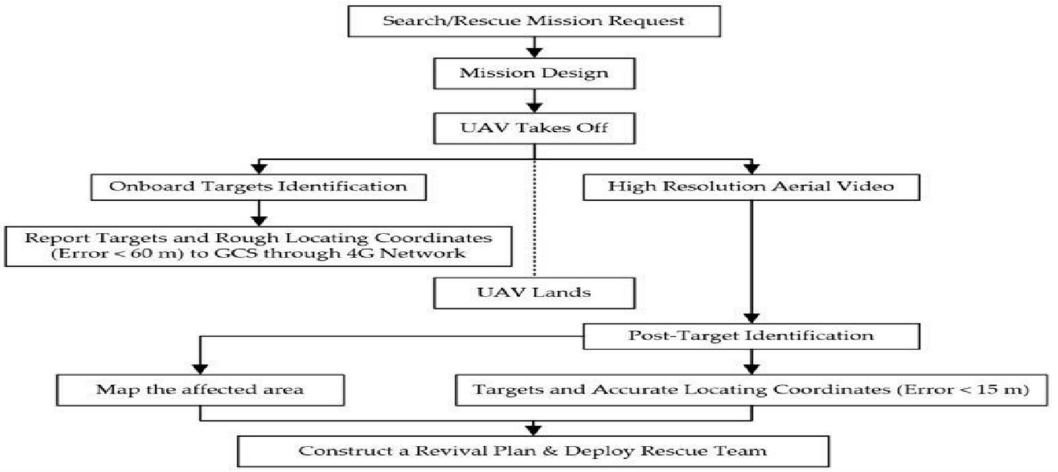
Drones can be used as a part of ROP, which is a squad of security personnel that is deployed for checking the safety on both sides of the road during the movement of security convoy/VIP, in areas affected by terrorist activities. These bomb clearance squads have metal detectors and other gadgets for bomb detection and clearance, but are essentially at high risk of loss of life and/or limb due to the nature of the work.

Using Drone Surveillance, ROPs will be able to see both sides of road before arrival physically and locate the suspected device, if present. They would also be able to detect the type of device implanted and the probable equipment required for safe disposal.

Example picture of Cylinder and Mines placed under Road

3.2.2 Advance scanning for area/VIP security

Before arrival of VIPs or at mass gatherings, the whole venue can be scanned by a drone and recorded in high-resolution aerial video that can be used real-time, in post-processing tasks such as target identification and mapping the targeted area. This system is depicted in flow chart below:


Search/Rescue Mission Request
Mission Design
UAV Takes Off
Onboard Targets Identification
High Resolution Aerial Video
Report Targets and Rough Locating Coordinates (Error < 60 m) to GCS through 4G Network
UAV Lands
Post-Target Identification
Map the affected area
Targets and Accurate Locating Coordinates (Error < 15 m)
Construct a Revival Plan & Deploy Rescue Team

3.2.3 Reduced risk to security personnel

A drone has the capability of flying over danger zone with controllable speed and

scan through the land scape and process aerial images which tell about the topography of the required location and further more provide us real time feed of the required zone with all the happening being recorded and telecommunicated to the forces who can analyse the gravity of the situation and with planning beforehand can make a fascinating plan to perform a successful operation in case of any suspicion or danger.

3.3 Role of Drones in Bomb Detection

3.3.1 Location of Suspected object

At present, the same task is performed by BDDS. It is very difficult to search everything. The time consumed also is very high. Further, some IEDs can be booby-trapped or hidden from human eye with camouflage or kept in place inaccessible to human eyes, all of which place great risk on the lives of the personnel.

When an IED is detected, it is unknown if there is only one IED present or more are located in the area where the first IED was detected. Detection of one IED not only creates anxiety within the team due to the risk but also it creates additional pressure as they have to rush and search through everything hurriedly due to the unpredictability of the situation. This situation can be easily avoided by usage of drones which can detect the above-mentioned crises and thereafter give total knowledge of the scenario to the team in-charge, who can fix priorities and search and defuse the bombs or body-traps in a planned manner. This would help in lessen anxiety levels and thus reduce the chances of mistakes and ensure faster and more proficient work.

3.3.2 Remote Identification of Suspected Device

Currently BDDS performs this duty with the help of various technical equipment like DSMD (Deep Search Metal Detector), NLJD (Non-Linear Junction Detector, ED Dogs etc. During use of these equipment BDDS members go near the suspected device which involves the risk to life. If a drone includes the above equipment technology, it would be easy to identify remotely the suspicious object whether it is

an IED or something else. Currently some of above technology used by other counties like Digital Dog Nose Drone, Laser Detect System, Metal Detector etc.

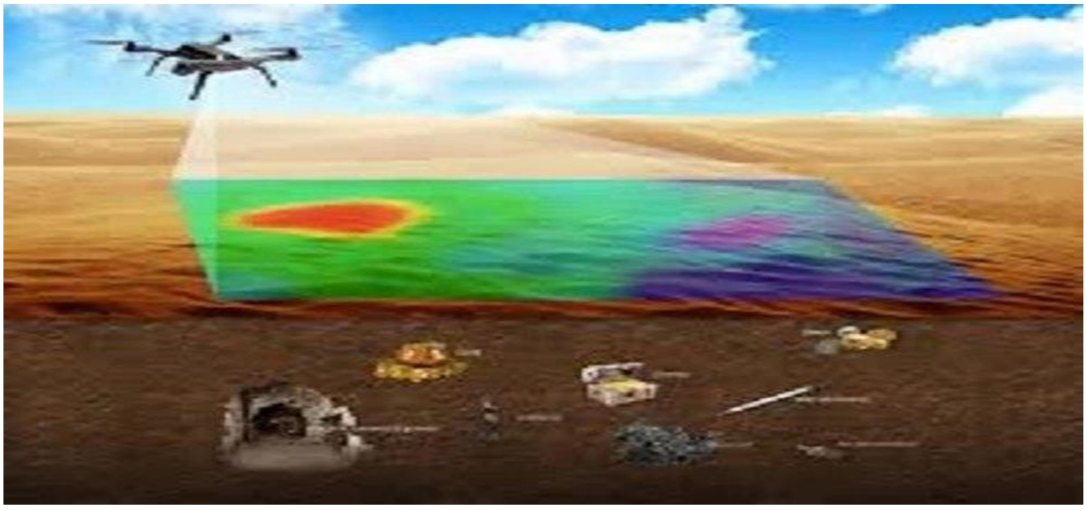
3.3.3 Digital Smelling Technology in Drones

Drones with digital dog nose sensors could replace actual dogs for sniffing of explosives (the digital dog nose project was originally founded by DARPA (Defence Advanced Research Projects Agency, USA). Such a drone can also be used for:

- Finding illegal drugs
- Detecting gas leaks
- Detecting viruses
- Detecting chemical weapon/toxic chemicals.

3.3.4 Drone with metal detection capability

Drones can also be made capable of detecting metallic (magnetic and non-magnetic) items in under the earth surface to detect metal used in mines, Improvised Explosive Devices (IEDs) & Unexploded Ordnance (UXOs)etc.



3.3.5 Drone with Laser Detect System

Utilizing laser-based explosive detection system, drones can detect explosives and other hazardous materials in gas, liquid, powder or bulk form, at a distance of several meters from the threat. Such drones can be configured to perform such missions over an operational radius of up to 3 Km. But this has a

drawback also as while using LASER an explosive can get detonated or laser sensitive IEDs can explode.

3.4 Role of Drone in Bomb Disposal

Drones can be used to lift and carry a suspected object/IED to the Safe Disposal Area (SDA) in certain circumstances.

Currently, BDDS teams use Telescopic Manipulator or traditional bamboo lathi to lift a suspected device. Remotely Operated Vehicles (ROV) costing around Rs.1-3 crore are also used for this purpose. However, Delivery Drones with robotic arms or jaw-type technology are used to lift a suspected device then it would prove to be cost-effective especially in case the device explodes. It would also be more safe as when a ROV has to carry a suspected device, sometimes it has to pass through crowded areas, which can be risky.

3.4.1 Challenge in Bomb Disposal by Drone

By using the ROV, a BDDS team not only carries the suspected device but can also take X-Ray of the suspected device using RTVS System (Real Time Viewing System).Thereafter; a water jet disruptor is used for a controlled explosion. For drone to be useful in bomb disposal, it requires to be equipped with these functionalities or suitable alternatives.

3.5 Drones can be used as Explosive Ordnance Disposal (EOD) robots

With respect to bomb detection and disposal, this use of drones would help replace humans that work in hazardous environments thus ensuring worker safety and improved detection and neutralization.

3.5.1 Operation and Detection

The Drone operator can remotely control the UAV to grasp, transfer, and destroy bombs. After identifying the type of explosives, the operator can perform the task of detection of explosives and further through R&D, high recognition accuracy and strong maneuverability can be achieved in the long run. The EOD Drone system offers many advantages over traditional mode of explosives defusal, for example it can provide decision makers with accurate information on the location of the explosive and at the same time mitigate potential casualties in the explosive defusal process by avoiding physical human interference.

3.5.2 Impact

The positive operational impact of deploying EODs and small Unmanned Aircraft Systems [sUAS — These are small fixed wing drones often used for ISR (Intelligence Surveillance & Reconnaissance)] is to send flying sensors into locations that are too dangerous or impractical for humans. The dangerous situations of high altitude, airborne, or exposure to radioactive or bio hazardous material, or blast fragmentation poses threat to human entry in such cases sUAS are very useful.

However the job requires patience, situational based judgment and the critical skill to navigate in the most life threatening dangerous situations. As teams examine every possible avenue for technology to make their operations safer, sUAS and EODs have emerged as one of the most effective ways to ensure successful execution of a desired task while buying down risk to personnel and property.

CHAPTER 4

DRONES FOR MAINTENANCE OF LAW AND ORDER ESPECIALLY IN FAR-FLUNG AREAS

4.1 Crowd Monitoring

Monitoring large events like concerts, parades and sporting events is extremely expensive and requires a great deal of manpower. All available agents are deployed to monitor various routes and areas where there are security concerns. This strategy results in many agents covering a single task, watching even if nothing happens.

Field Police teams equipped with drones give police a wider field of surveillance over a larger area with less manpower resources. Drones with HD camera enable surveillance teams with a top view of areas of interest, giving the police the ability to remotely assess threats, such as suspicious objects or possible scuffles. The information provided by drones enables police to make the critical decision to send ground teams to incident locations based on real time necessity, thereby avoiding wastage of resources.

4.2 Drone can be used for deploying tear gas or smoke:

Drones are a useful tool for deploying tear gas or smoke at different situations, including crowd control and riot management. Drones with sophisticated targeting systems and real-time data analysis skills can more safely and precisely deliver tear gas or smoke to designated areas. This method increases the overall efficacy of law enforcement agencies in their security operations by reducing the risk to personnel and enabling a more regulated and efficient dispersion of non-lethal munitions.

4.3 Surveillance

Stakeouts are a common police activity involving hours of waiting and watching. Police can leverage drone technology to monitor places and things that regular fixed CC cameras cannot. Drones are flexible to use in such a way that the camera can be pointed and zoomed at the target from concealed locations that humans cannot reach. Additionally, there are places like the middle of a field, where there is no

vantage point to conduct standard surveillance without being seen in such cases, a high-flying drone offers the best opportunity to get good views of the scene.

4.4 Case Study of West Bengal (Gosaba Assembly Constituency) There had been several incidents in the pre-poll phase of the West Bengal Assembly Elections – 2021, in the Gosaba assembly constituency and it was felt that a system was needed which would augment the police to have better control of the area during the polling day of the elections. The area comprises of several riverine islands which are completely separated from the mainland. The Sundarbans biosphere reserve falls under this assembly constituency. There are nine (9) inhabited islands in the assembly constituency. The movement of the police is a definite challenge due to the terrain. The normal modes of transport on these islands are 2-Wheelers and 3- Wheelers. There are mechanized and fast interceptor boats for traversing from one island to another. The normal modes of transport on these islands are 2-Wheelers and 3- Wheelers. There are mechanized and fast interceptor boats for traversing from one island to another. Normal 4-wheeler police vehicles cannot be used. Transport of CAPFs, communication and other machinery is very difficult.

4.4.1 Drone Monitoring System

The law and order situation during the poll process could be effectively controlled using Drone monitoring system. The system which was implemented helped the local police in maintaining a sharp vigil especially over the sensitive areas which had seen several incidents during the pre- poll phase of the assembly elections.

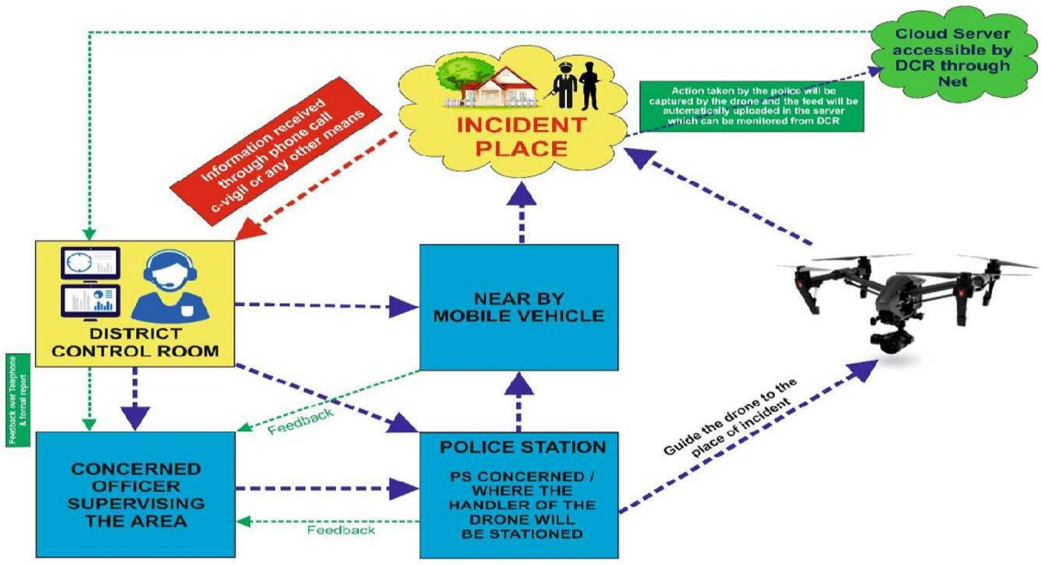
The system captured, recorded, and stored the situations during the poll day. Any action taken by the police was also recorded by the system. The footage could also be used as evidence in the future and most importantly the drone monitoring system acted as a strong deterrent tool for the trouble mongers on the polling day.

4.4.2 Description of the system that was created

A total of nine (9) drones were used to strategically cover all nine riverine islands. The flight was controlled from nine pre-identified strategic locations on the different

islands (shown on the map below). The maximum distance achieved between the controller and the drone was seven (7) kilometers. The drones flew at a maximum altitude of 6000meters above sea level. At a stretch, the drones flew up to thirty (30) minutes. All the drones and batteries were hired from a vendor and the total cost was Rs. 4,50,000/- (Rupees four lakhs fifty thousand only).

The footage captured was uploaded simultaneously to a secure cloud server. This was viewed in the control room through a desktop with a proper internet connection.


Cloud Server accessible by DCR through Net
INCIDENT PLACE
Action taken by the police will be captured by the drone and the feed will be automatically uploaded in the server which can be monitored from DCR
Information received through phone call c-vigil or any other means
DISTRICT CONTROL ROOM
NEAR BY MOBILE VEHICLE
Feedback
CONCERNED OFFICER SUPERVISING THE AREA
POLICE STATION
PS CONCERNED / WHERE THE HANDLER OF THE DRONE WILL BE STATIONED
Feedback
Guide the drone to the place of incident

A local police officer was assigned to each of the nine handlers to guide and send the drone to places of interest.

The following benefits accrued from this system:

a. The drone monitoring system helped in better supervision; prompt action and recording of the exact incident for later evidence.

b. The drone monitoring system brought transparency in the election process.

c. It had a strong deterrent effect on the trouble mongers.

d. It built a sense of confidence in the public in the particular Assembly Constituency.

e. The feed of the drones was seen in the control room kilometers away.

4.4.3 Drone specifications used in the Assembly Elections 2021

Specifications	
Max Service Ceiling Above Sea Level	19685 feet (6000 m)
Max Flight Time	Approx. 30 minutes
Satellite Positioning Systems	GPS/GLONASS
Operating Frequency	2.400 - 2.483 GHz
Max Transmission Distance	2.400 - 2.483 GHz (Unobstructed, free of interference) FCC: 4.3 mi (7 km) CE: 2.2 mi (3.5 km) SRRC: 2.5 mi (4 km)
Battery	6000 mAh LiPo 2S
Operating Current/Voltage	1.2 A@7.4 V
Sensor	1" CMOS Effective pixels: 20M
Lens	FOV 84° 8.8 mm/24 mm (35 mm format equivalent) f/2.8 - f/11 auto focus at 1 m - ∞
Image Size	3:2 Aspect Ratio: 5472 × 3648 4:3 Aspect Ratio: 4864 × 3648 16:9 Aspect Ratio: 5472 × 3078

Specifications	
PIV Image Size	4096×2160(4096×2160 24/25/30/48/50p) 3840×2160(3840×2160 24/25/30/48/50/60p) 2720×1530(2720×1530 24/25/30/48/50/60p) 1920×1080(1920×1080 24/25/30/48/50/60/120p) 1280×720(1280×720 24/25/30/48/50/60/120p)
Still Photography Modes	Single Shot Burst Shooting: 3/5/7/10/14 frames Auto Exposure Bracketing (AEB): 3/5 bracketed frames at 0.7 EV Bias Interval: 2/3/5/7/10/15/20/30/60 s

Specifications	
Photo	JPEG, DNG (RAW), JPEG + DNG
Video	MP4/MOV (AVC/H.264; HEVC/H.265)
Live View Working Frequency	2.4 GHz ISM
Live View Quality	720P @ 30fps
Latency	220 ms 160 - 180 ms
Stabilization	3-axis (pitch, roll, yaw)
Controllable Range	Pitch: -90° to +30°
Max Controllable Angular Speed	Pitch: 90°/s
Angular Vibration Range	±0.02°
Battery Type	LiPo 4S
Capacity	5870 mAh
Voltage	15.2 V
Max Charging Power	160 W

4.4.4 Drawback

The system was implemented successfully but the flight time was on the lower side. Police had hired Mavic Pro 2 drones. There were spare battery backups for each of the nine drones, but a higher flight time was desired and this was a major drawback.

4.4.5 Outcome of the experiment

This usage of drones in the elections can be done in the future, for the conduct of elections, especially for the terrains which are normally inaccessible. Mountainous regions, riverine islands, thick jungles, etc. are some of the places where drones can augment the work of the police during elections or otherwise

CHAPTER 5

USE OF DRONES IN CONFLICT ZONES AND BORDER SECURITY

India has a land border of 15,106.7 Km. The length of our land borders with neighboring countries(in km) is Bangladesh- 4,096.7, China-3,488, Pakistan-3,323, Nepal -1,751, Myanmar-1,643, Bhutan-699 and Afghanistan -106. These international borders are guarded by different Central Paramilitary Forces like Border Security Force (BSF), Indo-Tibetan Border Police (ITBP), Sashastra Seema Bal (SSB) and Assam Rifles (AR).

Drones, or unmanned aerial vehicles (UAVs), have become an increasingly integral to security operations undertaken by the border guarding forces. Drones offer several advantages, including real-time surveillance, rapid deployment, and cost-effectiveness compared to traditional manned patrols. Some key uses of drones in border security are as under:

1) Surveillance and Monitoring

Drones equipped with high-resolution cameras, infrared sensors, and thermal imaging technology provide continuous surveillance over vast and often inaccessible border areas. They can detect unauthorized crossings, human trafficking, and smuggling activities, especially in difficult terrains such as deserts, mountains, and dense forests.

Usage of Drones in Border Guarding

Drones are the future of Policing and Border Guarding. Gradually finding multi-dimensional utility in domain of Border Management. Few of the sectors identified that have wide utility are as under

(a) ISR (Intelligence Surveillance & Reconnaissance)
  (i) Surveillance on International Border
  (ii) Artillery Spotting and Direction

(iii) Target Illumination

(b) Defence and Counter Measures
  (i) Drones against Drones
  (ii) Drones against Criminals
  (iii) Munitions Drones

(c) Deployment Assistance
  (i) Spraying on Sarkanda growth to increase the visibility and for area domination by the patrolling troops
  (ii) Replenishment of Arms & Ammunition – in on-going operations or in high altitude locations from base camp as drone will be much faster
  (iii) Area Mapping
  (iv) To detect the change – Surveillance by drones in remote border areas through the captured images helps in monitoring as well as in detecting any change, for e.g. any kind of construction

(d) Welfare
  (I) Delivery of Essential Items
  (II) Life Saving and Health Care

2) **Rapid Response**

In the event of a suspicious activity, drones can quickly be deployed to the location, providing real-time video feeds to Control Centres. This rapid response capability helps in assessing situations promptly and determining the necessary actions.

3) **Intelligence Gathering**

Drones can collect valuable intelligence on the movement and behaviour of potential threats along the border. This data can be used to identify patterns, predict future activities, and improve the overall security strategy. Advanced drones can also carry communication interception equipment to monitor illegal communication channels used by Anti-National element (ANEs), terrorists, smugglers and traffickers.

4) **Search and Rescue Operations**

Drones are highly effective in search and rescue missions, especially in remote and hazardous areas. Equipped with thermal imaging, they can locate individuals lost or

in distress, aiding in timely rescues. This capability is particularly important in regions with extreme weather conditions or rough terrains where traditional search methods are challenging.

5) **Early Warning Management**

Drones can be deployed to check interventions and convey timely warnings before sending the patrolling party in adverse situations or in conflict areas.

6) Cost-Effectiveness

Drones are a cost-effective alternative to traditional manned aircraft and ground patrols. They require less manpower, lower operational costs, and can be deployed more frequently and flexibly. This makes them an efficient tool for continuous monitoring without the high costs associated with manned operations.

7) Deterrence

The presence of drones can act as a deterrent to potential illegal activities. Knowing that the border is under constant surveillance makes it less likely for Anti-National element (ANEs), terrorists, smugglers, traffickers, and illegal immigrants to attempt crossing. The psychological impact of being watched can significantly reduce the number of illegal crossings and related activities.

8) **Coordination with Other Technologies**

Drones can be integrated with other security technologies such as ground sensors, radar systems, and communication networks to create a comprehensive border security system. This integration enhances the ability to detect, track, and respond to threats more effectively. For instance, drones can be used to verify alerts triggered by ground sensors, providing a visual confirmation before dispatching ground units.

9) **Flexibility and Versatility**

Drones come in various sizes and capabilities, from small quadcopters for short-

range surveillance to larger fixed-wing drones for long-range missions. This versatility allows for tailored solutions depending on the specific needs of a border region. They can also be equipped with various payloads, including cameras, sensors, and communication devices, to suit different operational requirements.

CHAPTER 6

CHALLENGES POSED BY DRONES FOR POLICE

Notwithstanding the plethora of benefits the liberalized Drone Rules- 2021 offer and the fact that drones serve as a 'force multiplier' for the police, they may pose serious security challenges if misused by anti-social elements. A few such scenarios are broadly summarized below:

a) Where drones are being operated by amateur/unsophisticated operators and venture into restricted areas, they can thus create a nuisance, lead to violation of privacy and trespassing.

b) The anti-national/rogue elements may procure a non 'NPNT'(No Permission No Takeoff is a software programme that enables every remotely piloted Aircraft (except nano) to obtain valid permission through digital sky platform before operating in India)compliant Drone and operate to threaten a vital installations, public gathering, VVIP, etc.

c) The Airspace Mapping with Drone Flying Zones and Geo- Fencing are not physical barriers in the sky that will limit the flying or operation of such Drones to the specified zones.

d) A 'NPNT' compliant Drone may be hijacked by threatening the owner or stolen and used to carry out an attack.

e) Commercially-Off-The-Shelf (COTS : Civilian drones that can be used for a variety of purposes such as video/photography, movie shootings, etc.) drones can be weaponized easily by rogue elements with some customization and little investment, while Counter Drone Systems are expensive, each with limited capability.

f) A significant number of high-rise structures in a city can impede the early detection of drones. Nano, Micro and Small Drones in urban built up areas pose challenges in timely detection.

g) There is non-availability of a wide blanket anti Drone defense umbrella that can ward off any type of attack from Drones in cities where a large

number of sensitive and vital installations are located and regular VVIP movements take place. Designing and making one such anti Drone system is prohibitive in cost. For example, the Indian Army recently inducted an initial lot of seven new indigenous integrated drone detection and interdiction systems (IDD&IS) for deployment along the northern borders with China. The vehicle-based IDD&IS, which provide for both “soft kills” of hostile drones through jamming and “hard kills” through lasers, has a detection range of 5 to 8 km. While the “soft kill” can jam the drones at ranges from 2 to 5 km, the effective “hard kill” range is over 800 meters. Each IDD&IS costs around Rs. 20 crores. For a metropolitan city like Hyderabad with approximately 30km radius, about 40 drones costing around Rs.800 crores is required.

h) Threat from Large Drones (above 150 kg) by rogue elements at present is unlikely, as it is expensive, easily detectable on being airborne, and hence can the utilization of much smaller platforms (Nano and Micro Drones) for delivering weapons and explosives in near future could pose a challenge to Police.

i) The accountability of a large number of unregistered Drones (more than six lakhs till 2019), that are mostly Non- NPNT compliant, is a major challenge to the police.

j) Privacy Concern of the citizens/individuals: Drones with cameras can be intrusive and could violate an individual’s right to privacy. Use of Drones in public places may pose risk to safety of public under surveillance as their consent is not taken and rogue elements may misuse the captured photos/videos.

k) The malfunctioning or drone collisions possess high risk.

l) Data protection challenges with Drones: Drones collects data such as photos/videos of public events, vehicles, individuals, GPS coordinates and other sensitive information and this data must be handled in accordance with data protection laws.

m) Ethical concerns: Drone technology enables police officers to spend less time interacting with citizens. This may give rise to broad concerns that such physical alienation might desensitize police to the concerns of the public.

n) Restricted airspace: Certain airspace in India is restricted, and drones should not fly in these areas. This includes restricted areas around airports or other government facilities.

o) Absence of Counter Rogue drone unit for Police/CAPF's.

p) Technical limitations: Many drones (Rouge drones) come with unique technical specifications, data encryption, and communication protocols. Forensic tools need to be innovative and adaptable to decode these protocols and extract relevant evidence effectively.

CHAPTER 7

SUGGESTED STRUCTURAL FRAMEWORK

(Based on case study from the State of Telangana)

7.1 Establishment of Multi-Department Agency in Telangana

Since drone operations entail technology, air operations, and commerce and are performed very close to the civilian population having an overbearing effect on public safety, there is an urgent and compelling need to establish a multi departmental agency in Telangana to ensure highly coordinated, smooth, and safe Drone operations. The organization is recommended to be named and spelled as 'Hi-DRA', (pronounced as 'Hydra') which stands for highly integrated Drone Regulating Agency. The recommended key features of Hi-DRA are: -

a) Be an agency adjunct to the Counter Intelligence (CI) Branch of State Police and function to collect, maintain, and investigate the cases of Rogue Drone users. Other members could be from Police Technical Services, IT&C Department, Counter terrorist Force, etc.

b) Serve as a repository of all data about Drones within its jurisdiction viz: Drone type, Manufactured Details, License No, UIN, details of Drone Owners, Remote Pilot License, Serviceability, repair and maintenance and discard details.

c) Be a nodal agency at State to create awareness among the public about Drone Rules (Emails/bulk SMS). Can also serve to resolve the queries/grievances of drone users.

d) Function as a vital link between the local ATC and UTM with the knowledge of real-time airspace status. Act as a redundancy in the event of a temporary breakdown of the UTM/ATC link due to a technical glitch/Cyber- attack.

e) Frame, disseminate, monitor, and review the SOP and Rules of Engagement for dealing with the rogue Drone threat, in keeping with the changing threat/ technology and Drone Policy/guidelines issued by the DGCA from time to time.

f) Train the City/District Police to deal with Rogue Drones.

g) The response mechanism in Capital City/District could be as under :-

i. Static and Mobile Detachments positioned with City Police HQs.

ii. Detection by Detection Detachments.

iii. Interdiction by Counter Terrorist Force (CTF) of State Police. It is recommended to equip CTF with Drone neutralization.

a. Equipment viz; Net Firing Guns/Drone Hunters, SMASH 2000.

b. Fire Control System and High Power Laser. This entails imparting.

c. Training to the CTF in both the Soft Kill and Hard Kill mechanisms.

iv. For training in the detection, identification, and interdiction of drones, personnel retired early (VRS) from Indian Air Force can employed on a regular/contractual basis.

7.2 State Level Committee

A committee is established at the State/UT level, committee members consisting of Counterintelligence Head of Operations, Pr. Secretary, Home, etc. and headed by competent authority. The committee shall, meet with the representatives from Indian Air force, Ministry of Home Affairs, DGCA and other stakeholders on periodical (6 months) basis or at least once a year to review, discuss and resolve all the issues regarding Drone operations.

Composition of State Level Committee:

The Committee can be headed by the Principal Secretary of Home Department, State of Telangana, and represented by various state and central agencies or their representatives as under:

Chairman: Home secretary, State of Telangana

Members:

a) ADGP Law and Order
b) IT Secretary, State of Telangana
c) Commissioner of Police, Hyderabad
d) Commissioner of Police, Cyberabad
e) Commissioner of Police, Rachakonda
f) IG Counterintelligence
g) ADG Octopus
h) IG ISW – Member secretary
i) Regional Director BCAS Hyderabad
j) Joint commissioner DGCA
k) Station Commander AF station IAF Begumpet and Hakimpet Hyderabad
l) Joint Director IB
m) GOC HQ Andhra Sub area command Army Bollarum
n) Deputy Director, Special Bureau Hyderabad
o) Commandant NSG Hyderabad

7.3 Subcommittees/Task Force Teams

Apart from the above State level committee which meets once in 6 months, it is proposed to form subcommittees to perform various other tasks related to drone regulation and awareness at the statewide level. At the state level, ISW can be anodal agency while at the district level SP/CP can be a nodal agency to perform these functions, and separate staff may be assigned with the requisite capabilities on a deputation basis.

i. Education and enforcement team

- Identification and registration of unregistered drones
- Creating awareness about drones and drone rules
- SHOs to approach all function halls, event managers, photographers, and media persons to register their drones
- An online simple-to-use link may be provided where an existing user of the drone can upload his/her digisky
- screenshot, details of manufacturer, purchase receipt, communication details like address & contact number, email of user, etc.
- Grievances of drone users and their redressal.
- A deadline can be put for the registration of unregistered drones and a penalty be imposed after the deadline.
- Wide publicity can be given via hoardings/media statements/social media on registering the drone in digisky and updating drone ownership transfer details or lease or operator details and license details of pilot periodically
- In the future, some air spaces can be declared open as drone corridors or airspace suitable for flying commerce/cargo deliveries
- Designate TSPA as an R & D state institution thereby getting all exemptions under Drone rules 2021for procurement and flight
- All law and order and traffic police stations can take ownership in creating awareness about drones and drone rules and encouraging registration of existing drones.

ii. **Investigation Support and monitoring team** on rogue drone/drone incidents by recording collecting and maintaining such instances and developing capabilities on drone forensics

iii. **Purchase, monitoring and training team** - Drone Academy Begumpet, a government agency, can be a member to impart training for drone users. GEM portal has various models of drones that can be used for purchase.

iv. **Communication and Coordination team** - To real-time monitor the link between ATC/UTM and State Police Control Room and monitor Dig sky Real-time – ISW can be a nodal agency.

v. **Detection team:** Apart from police agencies, citizens must be encouraged to report drone sightings via Dial 100/Hawk- eye/ Facebook/Twitter/WhatsApp, etc. A Drone Sighting Report may include details like:

- Place of sighting
- Time of sighting
- Duration of flight
- Approximate height
- Physical features of drone-like color, shape, size
- Sighting of drone operator and his/her face or body features
- Vehicle details if any of drone operators like make and model and color and vehicle number of vehicle and direction of vehicle movement.
- Make and model the drone if known.
- If the drone has dropped any object, then the location and size and shape, and color of the object so dropped.
- Image/Video of drone flight as an attachment
- Map location as an attachment
- Sound details and description of the drone
- Details of citizen like name address phone number etc.

vi. **Operations team:**

- A counter-drone operations team with hard and soft kill capability
- Limit VVIP static “No Drone” in Dig sky to CM residence, High Court, Raj Bhawan, Assembly, DGP Office
- The capability of 5 mobile anti-drone vehicles for use in the field like in CM rallies, CM convoys, international events, IPL matches, etc.
- Garuda teams are to be deployed for eagles training and use in the field.

7.4 Police Drone Squad For Countering Rogue Drones

In addition to above information smaller squads can also be formed gist is provided below: -

Police Drone Squads for countering Rogue Drones should be able to detect, identify, and mitigate threats posed by them. For this, advanced sensors, radar, thermal imaging to identify rogue drones, secure communication for real-time information sharing and coordination to counter the rogue drones will be necessary. The squad should be mobile for quick response.

Hence, It is suggested that each drone squad should be formed consisting of three to four drones per vehicle. The drone may further be allocated as given below.

i. Two big drones and one or two small drones where one of the big drones is used for continuous surveillance during big rallies of VVIP/VIP or mass gathering and is connected to the vehicle for continuous battery backup, to cover the area in radius of two to five kilometers (depending on camera usage).

ii. The second big drone can be used in two ways: first, by capturing rogue drones by using nets and second, being installed with robotic arms to pick any suspected device.

iii. Third and fourth drones can be used for surveillance on the places which are inaccessible to the big drones, like covered areas.

iv. The estimated cost of forming one drone squad along with vehicle would be around Rs. 1.25 to 1.30 crore.

v. With the help of drone squad, live streaming of full operation is also possible at headquarters. It is important to assess the effectiveness of operations regularly and adapt tactics and technologies based on emerging threats and advancements in drone technology.

NOTE: For more details regarding Countering Rogue Drones, a separate project has been undertaken in NPM which may be referred to for more information.

Annexure - 1

Technical Specification of Micro and Small Drones for Surveillance

1. General Specifications

S.No.	Descriptions	Specifications
1.1	Role	Surveillance, Reconnaissance, and detection during day and night operations
1.2	UAV Weigh with battery and standard payloads	Between 250gms to 25 kgs
1.3	Endurance	40 minutes or more with all payloads at mean sea level
1.4	The range for live transmission (Radius)	4 km or more
1.5	Typical Cruise Speed	25 km /hours or more
1.6	Operating altitude (AGL)	400m AGL (Above Ground Level) or more
1.7	Maximum launch altitude (AMSL)	2000m AMSL (Above Mean Sea Level) or more

1.8	Flight Mode	a. Fully Autonomous Vertical Takeoff b. Fully Autonomous Vertical Landing c. The drone confidently hovers at a defined waypoint, maintaining position hold with an impressive accuracy of less than 25 meters. Autonomous waypoint navigation (pre-defined as well as dynamically adjustable waypoints during flight) d. Remote Piloted mode for Video-based user navigation. e. Vision-based autonomous target Tracking of fixed and moving targets f. Should be controllable in real time for GCS up to recovery g. Fully autonomous and stabilized.
1.9	Launch and Recovery Mode	i. Vertical Take-off and landing (VTOL) from within an area of 25m x 25m clearing or less ii. Payload should not damage during recovery of the UAV
1.10	Payload Carrying Capability	Should have the capacity to carry Electro-Optic Sensors (EO) for day and Thermal imager for night one at a time.

1.11	Operating Wind Conditions	The drone adeptly adjusts its take-off, landing, and operational procedures, seamlessly adapting to varying wind conditions while maintaining speeds of 25 kilometers per hour or higher.
1.12	Failsafe features	a. Return to Home on communication failure b. Return to Home/Land o c. Return home on high winds d. Multiple GPS on-board for GPS failure redundancy
1.13	Autonomy	Fully autonomous from Take-off to Landing without using any R/C controller
1.14	Propulsion System	Electrical with rechargeable batteries

2. Payload Characteristics for Micro and Small Drones

S.No.	Descriptions	Specifications
2.1	Payload Required	a. Electro-Optic Sensors for the day (color) b. Thermal imager for night c. Combined in the single payload or different payloads for day and night
2.2	Payload and video stabilization	a. All payloads should be gimbals stabilized on board b. Video output should be digitally stabilized at all zoom level c. The quality of the video should not be affected by UAV vibrations.

2.3	Thermal Imager Night Payload	a. Color Camera with 360° Pan and 90° tilt control b. Resolution: 720P or better c. White/black Hot modes d. Digital Zoom 4x or more Should be able to detect Human size targets at 300m or more The height and angle at which a drone camera can detect a human-sized target with a thermal imager in the night can vary depending on several factors, viz. environmental conditions, specifications of thermal imaging camera, etc.
2.4	Night Recovery Beacon	Switchable (from GCS) LED light when operating with night payload.
2.5	Electro-optic daylight payload	a. Color Camera with 360° Pan and 90° tilt control b. Resolution: 720P or better c. optical Zoom 10X with minimum FOV 5 degrees or less. Additionally, 4X Digital Zoom. Max. FOV 45 degrees (wide field) d. Should be able to detect Human size targets at 600m or more. The optimal height and angle for detection may depend on factors like the target's surroundings, the desired level of detail, and the specific capabilities of the thermal imaging system used on the drone. It's worth noting that advancements in thermal imaging

		technology continue to improve the detection capabilities of drone-mounted thermal imagers.

3. Ground Control Station (GCS) Software Features: -

Sr. No.	Parameter	Specifications
3.1	GCS should have MIL-STD-810 and IP -65 or better for the flexibility to work freely in nearly any weather conditions, antiglare, sunlight readable, etc.	
3.2	Computing Hardware: -	
	CPU	Intel Core i5 v Pro Processor, 1.9 GHz or better
	Storage	At least 01TB
	Memory	4 GB or more
	Display	10 inch- 1024x768 XGA sunlight viewable
	Audio	Integrated Speaker
	Keyboard & input	Touch screen
3.3	Battery operation	Minimum 2 hours, Battery should be BIS Certified.
3.4	Battery charging time	Should be less than 3 hrs
3.5	Data Portability	Ports for data transfer to external secondary storage devices
3.6	Interface	HDMI/DP/VGA, USB, RJ45
3.7	Capability	a. Transmit Control Commands to UAV b. Receive UAV flight and propulsion parameters c. Receive, display and record real-time daylight video from UAV d. Capability to control UAV while on the move

3.8	CGS Application Software	a. The geographic map showcases the location of the UAV (Unmanned Aerial Vehicle) along with its trajectory, camera view polygon, waypoints, and flight plan. b. The real-time video feed from the UAV includes an on-screen display presenting crucial parameters such as the UAV's coordinates, target (payload) coordinates, range from the UAV, true North indication, and distance from the home location. c. Throughout the flight, both the geographic maps and real-time video are consistently displayed, ensuring continuous visibility and access to critical information. d. The user interface allows for resizable and switchable views of the geographic map and real-time video. With a simple click or button input, users can effortlessly switch between big. e. Artificial Horizon indicating UAV attitude.
3.9	Map Formats	Should have the capability of working with Google Maps. The application can download maps automatically after specifying location GPS Co-ordinates.
	Parameter	Specifications
3.10	Payload Control	a. Selection and Switch On/Off of payload b. Pan/Tilt/Zoom Control c. Point Payload to ground Co- ordinate function, d. Rerecording On/Off, e. Switch on/off night recovery beacon

3.11	User Controls	One-click Take-off/Land/Hover, set the altitude of the UAV, Waypoint navigation, Point payload to ground co- ordinate function, RPV Mode which allows UAV to be flown in semi- autonomous mode by looking at the onboard video
3.12	Video	a. The video should be recorded in any commonly portable video formats (AVI, MPEG, MP4, etc.) b. Video of the full flight should be recorded c. Should have the capability to take image snapshots at any time during the flight d. Software should be provided that will facilitate the extraction of imagery from the recorded video past flight.
3.13	Pre-flight checks	Self-test of UAV System, Output: go/no go

4. Communication link Characteristics:

S. No	Descriptions	Specifications
4.1	Communications Link	a. Transmit control commands from GCS to UAV b. Transmit parameter of UAV and payload to GCS c. Transmit Day and Night video from UAV to GCS
4.2	Frequency Band	Should operate on UHP frequency Band uplink and downlink. Preferably on License free Bank i.e. 2.4 GHz.
4.3	Link Type	Secured Digital uplink & downlink with AES encryption.

5. General System Requirements:

5.1	Assembly/Dis- assembly time	Less than 10 minutes
5.2	Life of UAV	Not less than 500 landings
5.3	Environmental conditions for operation & storage	The UAV and associated systems should be certified for operation and storage for the following environment conditions a. Damp heat 40°C at RH not less than 95% b. Operating & storage temperature -10°C to +55°C c. Ability to withstand dust, drizzle, and humid conditions
5.4	Portability and operation	The UAV should be battery- operated portable, light in weight, compact, for day & light surveillance, and capable of being carried and operated by one or two men.

5.5	Battery	The Intelligent Standard Lithium-based battery pack should have a backup of a minimum of 40 minutes or more, the battery should be BIS Certified.
5.6	Battery Charger	Suitable Universal battery charger to charge the batteries within 2 or 3 hours.
5.7	Accessories	a. Ergonomic waterproof backpacks: 01 Set b. Field Repair Kit: 01 Set c. Lithium-based battery packs: 03 Nos. d. Spare Propeller Set: 02 Nos. e. Spare Landing Gear Set: 01 No. f. Associating cable & mounting:01 Set g. Ruggedized transportation box: 01 Set h. User, Technical and maintenance manual: 01 Set i. Log Book: 01 Set
5.8	Guaranty/Warranty	One-year complete protection and 7-year availability of service & spare parts.
5.9	DGCA Approval/parameters	Must be regulation compliant as per DGCA, the following approval/parameters are mandatory for the operation of UAV: a. ETA (Equipment type approval) of UAV b. Import clearance from DGFT (Director General of Foreign Trade) only for Foreign OEM. c. NPNT (No permission No take-off) d. UIN (Unique Identification Number)

ANNEXURE – 2

Design of Explosive Ordnance Disposal (EOD) System

The drone system should be developed as an intelligent EOD system based on a six-rotor UAV (better fault tolerance) and with deep learning technology (neural network). The system should be able to detect, recognize, and seize unexploded ordnance on its own. The UAV can survey and scan the site with a high-resolution camera. The digital signal of the captured video would be sent to the ground station which can detect the returned video to accurately locate the UXO i.e. bomb. A small winch device and mechanical grapple can be installed at the base of the six-rotor UAV to grab, transport, and destroy the UXO. The entire process of removing and destroying UXO would be well outside the kill radius of explosives, significantly reducing casualties, which is important for security and stability. Compared to conventional bomb disposal techniques, the drone system has the advantage of accurate target recognition, rapid action, high mobility, and ease of operation. It overcomes the shortcomings of the traditional land bomb disposal robot, such as slow action speed, limited field view, and poor adaptability to the environment.

The main features of the drone EOD system are as follows:

1) An intelligent EOD system based on a six-rotor UAV when compared with the traditional blasting method, reduces the involvement of personnel, shortens the blasting time, avoids direct contact between personnel and UXOs, and makes the blasting work safer and more efficient.
2) Based on the principles of deep neural network, the target recognition method of a drone is adopted which can realize the automatic recognition of UXOs in patrol, complete the recognition task accurately and efficiently, and provide accurate information about the location of action of the UXOs to the decision-makers in the field during difficult EOD operations.
3) Based on the UAV safety and security requirements, a mechanical gripper with a corrugated inner edge was developed to firmly grip UXOs, and a winch device was developed to complete the lifting of the mechanical gripper and ensure that the UAV is outside the kill radius of the UXO's explosion during the blast removal process.

ANNEXURE - 3

Drone Rules, 2021 (excerpts)

As the sales of civilian drones rise, the safety concerns surrounding them among regulators and law enforcement agencies also tend to go up, seeing the past drone collisions with airplanes and crashes into crowded stadiums and delivering illegal items, and some other drawbacks of Drone, Govt. of India introduces Drone Rule 2021.

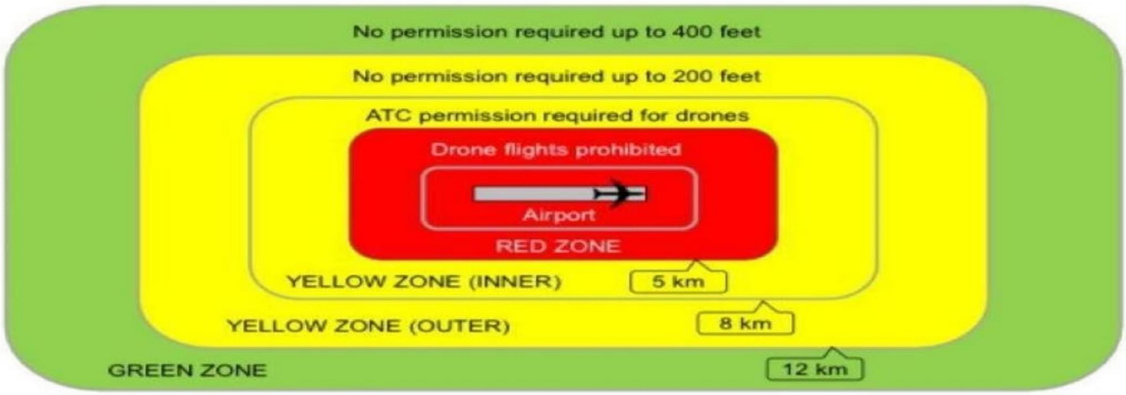
On 25th august 2021, the Ministry of Civil Aviation, Government of India notified the new Drone Rules. Their salient features relevant to police are as follows: -

- Rule 3 of Part I "THREE ZONES DEFINED

"Green Zone" means the airspace of defined dimensions above the land areas or territorial waters of India, up to a vertical distance of 400 feet or 120 meter that has not been designated as a red zone or yellow zone in the airspace map for unmanned aircraft system operations and the airspace up to a vertical distance of 200 feet or 60 meter above the area located between a lateral distance of 8 kilometer and 12 kilometer from the perimeter of an operational airport.

"Yellow Zone" means the airspace of defined dimensions above the land areas or territorial waters of India within which unmanned aircraft system operations are restricted and shall require permission from the concerned air traffic control authority. The airspace above 400 feet or 120 meter in the designated green zone and the airspace above 200 feet or 60 meter in the area located between the lateral distance of 8 kilometer and 12 kilometer from the perimeter of an operational airport, shall be designated as yellow zone;

"Red Zone" means the airspace of defined dimensions, above the land areas or territorial waters of India, or any installation or notified port limits specified by the Central Government beyond the territorial waters of India, within which unmanned aircraft system operations shall be permitted only by the Central Government;.



Drones Flying Area Limitations near Airport

- Rule 5 of Part II "Classification of unmanned aircraft systems" - The unmanned aircraft system shall, based on the maximum all- up weight including payload, be classified as follows:—

S. No	Category	Payload
1.	Nano UAV	Less than or equal to 250 grams
2.	Micro UAV	More than 250 grams, but less than or equal to 2 Kilograms
3.	Small UAV	More than 02 Kilograms, but less than or equal to 25 Kilograms
4.	Medium UAV	More than 25 grams, but less than or equal to 150 Kilograms
5.	Large UAV	More than 150 Kilograms

Part III of Rules - Certification of Unmanned Aircraft System - No person shall operate an unmanned aircraft system in India unless such unmanned aircraft system conforms to a type certificate or is exempted from the requirement of a type certificate under these rules The Central Government may, on the recommendation of the Quality Council of India, by notification in the Official Gazette, specify the standards for obtaining a type certificate for unmanned aircraft systems and such standards may promote the use of the following— (a) made-in-India technologies, designs, components and unmanned aircraft systems; and (b) Indian regional

navigation satellite system, namely, Navigation with Indian Constellation The Director General or any entity authorised by the Director General in this behalf, may, on the recommendation of the Quality Council of India or an authorised testing entity, issue a type certificate for any particular type of unmanned aircraft system. – (1) Any person, who intends to obtain a type certificate, shall make an application in Form D-1 on the digital sky platform along with the fee as specified in rule 46 and the following— (a) particulars of the applicant; (b) details and required documents in respect of the prototype unmanned aircraft system as specified therein; and (c) the prototype unmanned aircraft system shall be physically handed over to the authorised testing entity specified therein. (2) The Quality Council of India or the authorised testing entity shall examine the proposal and submit the test report along with its recommendations to the Director General within sixty days from the date of receipt of the application. (3) On the basis of test report along with the recommendations received under sub-rule (2), and on being satisfied, the Director General shall issue to the applicant a type certificate for the specific type of unmanned aircraft system within fifteen days of receiving such test report.

Rule 12 of Part III of Rules *"Mandatory Safety Features"*- (1) The Central Government may, in future, by notification in the Official Gazette, specify safety features to be installed on an unmanned aircraft system by persons owning it, which may include among others, the following safety features, namely:

a. 'No Permission – No Takeoff' hardware and firmware;
b. Real-time tracking beacon that communicates the unmanned aircraft system's location, altitude, speed and unique identification number; and
c. Geo-fencing capability.

(2) Every person who owns an unmanned aircraft system shall adopt safety features notified under sub-rule (1) within such period, not less than six months from the date of publication of such notification, as the Central Government may specify.

- Rules 14,15 & 16 Part IV "General", "Application and procedure for registration" & "Registration of existing unmanned aircraft systems"
- Rule 17 of Part IV "Transfer of unmanned aircraft systems"
- Rule 18 of Part IV "Deregistration of unmanned aircraft systems."

- Rule 21 of Part V “Mandatory pre-flight verification of zonal restrictions.”
- Rule 22 of Part V “Requirement of Prior permission to Fly”-

(i) No person shall operate an unmanned aircraft system in a red zone or yellow zone without prior permission

(ii) No prior permission shall be required for operating an unmanned aircraft system in a green zone, subject to the provisions of rule 21.

- Rule 24 of Part V “Temporary Red Zones”-

I. (1) If there is an urgent need to temporarily prohibit unmanned aircraft system flights in any specified area, the concerned State Government or the Union Territory Administration or a law enforcement agency may declare a temporary red zone over such specified area, for a period not exceeding ninety six hours at a time, by notifying it through the digital sky platform and highlighting it on the airspace map..

II. The temporary red zone shall be declared by an officer not below the rank of Superintendent of Police or his equivalent and such officer shall endeavor to keep the size of the temporary red zone reasonable and not excessive.

III. An endeavor shall be made to inform, through digital sky platform or other electronic means, to all holders of unique identification number who are within a distance of five kilometer from the perimeter of the temporary red zone, of the restriction so declared under sub-rule (1), but in case no such information is received, it shall not absolve a remote pilot of the responsibility to verify the zonal restrictions on the digital sky platform before commencing an unmanned aircraft system operation

- Rule 27 “ Prohibition on carriage of arms, ammunition, explosives and military stores, etc.”— No person shall carry or cause or permit to be carried in any unmanned aircraft to, from, within or over India, any arms, ammunitions, munitions of war, implements of war, explosives and military stores, except with the written permission of the Central Government or any other person

authorised by the Central Government in this behalf and subject to the terms and conditions of such permission.

- Rule 28 “Carriage of dangerous goods” — No person shall carry dangerous goods on unmanned aircraft unless such operation is in compliance with the Aircraft (Carriage of Dangerous Goods) Rules, 2003
- Rule 30 of Part V “Mandatory Reporting of an Accident”- No later than forty-eight hours after an accident involving an unmanned aircraft system takes place, the remote pilot of such unmanned aircraft system shall report the accident to the Director General through the digital sky platform.
- Part VI -Requirement of Remote Pilot License: (1) Any individual, who desires to obtain a remote pilot license for any category, sub- category or class of an unmanned aircraft system, or a combination thereof, shall complete the training specified by the Director General for such category, sub-category or class, and pass the tests conducted by the authorised remote pilot training organisation. (2) Within seven days of successful completion of the training and passing of the tests under sub-rule (1), the authorized remote pilot training organisation shall make an application for remote pilot license in Form D-4 on the digital sky platform along with the fee as specified in rule 46, providing details of the individual who has passed the test. (3) The individual in respect of whom an application has been made by the authorised remote pilot training organisation under sub-rule (2) shall be issued a remote pilot certificate through digital sky platform. (4) The Director General shall, within fifteen days from the date of issue of the remote pilot certificate under sub-rule (3), issue the remote pilot licence to such individual through the digital sky platform. “Validity of licence”: — A remote pilot licence shall— (a) be valid only if it is enlisted on the digital sky platform; (b) unless suspended or cancelled, remain valid for a period of ten years; (c) be renewed by the Director General for such period as may be specified therein, subject to a maximum period of ten years, on payment of fee as specified in rule 46: Provided that the holder of the remote pilot licence shall undergo such refresher course as may be specified by the Director General on the digital sky platform from time to time. “Exemption from obtaining licence” —— No

remote pilot licence shall be required for —— (a) operating a Nano unmanned aircraft system; and (b) operating a micro unmanned aircraft system for non-commercial purposes.

- Part VII “Remote Pilot Training Organization”- An application for authorization as a Remote Pilot Training Organization may be made on the Digital Sky platform by filling out Form D-5. The Requirements of syllabus, trainers, and infrastructure will be specified at a future date. If the applicant complies with all of the specified requirements, the license will be granted within 60 days of the application. The authorization is valid for 10 years.
- Part X “Insurance” - — (1) The provisions of the Motor Vehicles Act, 1988 (59 of 1988) and rules made there under shall apply, mutatis mutandis, to the third party insurance of unmanned aircraft system and compensation in case of damage to life or property caused by such an unmanned aircraft system: Provided that a Nano unmanned aircraft system may operate without third party insurance. (2) A person operating a unmanned aircraft system may use an insurance product specially designed for such operations, as and when such insurance product is approved by the Insurance Regulatory and Development Authority of India..
- Rule 46 of Part XII “Fee”- The fee payable for the services specified in column (2) of the Table below, rendered by the Central Government under these rules, shall be as specified in the corresponding column (3) of the said Table, namely:

S. No	Services	Fees (In Rupees)
1.	Issuance of Type Certificate	100/-
2.	Issuance, transfer or deregistration of UIN	100/-
3.	Issuance of Renewal of Pilot license	100/-
4.	Authorization or Renewal of authorization of Remote Pilot Training Organization	100/-

- Part V and XII “Penal Provisions”- Contravention of rules 22 and 27 shall be cognizable and non-compoundable. Further a heavy fine is imposed under Rule 50, while cancellation or suspension of any license, certificate,

authorization or approval granted thereunder is punishable under Rule 53. The details of which are as follows: -

- Rule 22- Requirement of prior permission:
    - No person shall operate an unmanned aircraft system in a red zone or yellow zone without prior permission.
    - No prior permission shall be required for operating an unmanned aircraft system in a green zone, subject to the provisions of rule 21.
- Rule 27 – "Prohibition on carriage of arms, ammunition, explosives and military stores, etc." - No person shall carry or cause or permit to be carried in any unmanned aircraft to, from, within or over India, any arms, ammunitions, munitions of war, implements of war, explosives and military stores, except with the written permission of the Central Government or any other person authorised by the Central Government in this behalf and subject to the terms and conditions of such permission.
- Rule- 49 "Offence classification & compounding"-
- No person shall carry out any activity in contravention of these rules.
- Notwithstanding anything contained in the Code of Criminal Procedure, 1973 (2 of 1974), the contravention of rule 22 and rule 27 shall be cognizable and non-compoundable.
- It shall be a defence to any proceeding for contravention of, or failure to comply with, these rules, if such contravention or failure is proved to have been caused due to factors or circumstances, such as stress of weather or other unavoidable cause or circumstances, beyond the control of such person or without his knowledge or fault.
- The provisions of these rules shall be in addition to, and not in derogation of, the provisions of any other law, for the time being in force.
- Rule- 50 "Penalties" - Where, after giving an opportunity of being heard, the Director General or an officer authorised by the Central Government or a State Government or Union Territory Administration, is satisfied that a person has contravened or failed to comply with the provisions of these rules, he may, for reasons to be recorded in writing, levy a penalty not exceeding rupees one lakh in accordance with the provisions of section 10A of the Act.

- Rule-53 Cancellation or Suspension- Where the Director-General, after given an opportunity of being heard, is satisfied that any person has contravened or failed to comply with the provisions of these rules, he may, for reasons to be recorded in writing, cancel or suspend any license, certificate, authorization or approval granted under these rules.
- Rule 48 of Part XII “General Power to Exempt” - The Central Government may, by a general or special order in writing, exempt any person or class of persons from the operation of these rules, either wholly or partially, subject to such conditions, as may be specified in that order.

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